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Revision 1

100-BC-5 Operable Unit Sampling and Analysis Plan

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Pacific Northwest National Laboratory for the
U.S. Department of Energy under Contract DE-AC06-76RL01830

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

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Summary

The 100-B/C Operable Unit comprises the groundwater beneath the 100-B/C Area of the Hanford Site. The 100-B/C Area housed two of the nine nuclear reactors on the Hanford Site involved in the production of plutonium.

This document describes groundwater sampling and analysis requirements for the 100-BC-5 Operable Unit. It specifies wells, aquifer sampling tubes, and shoreline springs to be monitored; constituents to be analyzed; and frequency of sampling. This monitoring plan differs from the previous plan slightly in the wells and constituents monitored. The changes were based on evaluation of data collected under previous monitoring plans.

The 100-BC-5 Operable Unit includes the groundwater beneath the 100-B/C Area and adjacent regions into which groundwater affected by operations in the 100-B Area may have migrated, including the Columbia River shoreline. The groundwater in the 100-BC-5 Operable Unit has been affected by past-practice discharge of liquid effluents to waste disposal facilities such as trenches, cribs, and retention basins. The groundwater operable unit does not include the waste disposal facilities and underlying vadose zone, which are associated with source operable units.

The Groundwater Performance Assessment project (groundwater project) has defined a series of "groundwater interest areas" within the Hanford Site for purposes of (a) interpreting all groundwater data comprehensively and (b) scheduling and sampling efficiently. Consequently, this sampling and analysis plan addresses an area larger than the operable unit, termed the 100-BC-5 groundwater interest area. The interest area extends westward from the 100-B/C Area to the boundary of the Hanford Site, and eastward to the boundaries of the 100-KR-4 and 200-BP-5 groundwater interest areas. The eastern part of the 100-BC-5 groundwater interest area is affected by groundwater contamination that moved northward from the 200-East Area.

Twenty-three wells will be sampled annually or biennially. Fourteen aquifer sampling tube sites and two shoreline springs will be sampled annually in the fall. Contaminants of concern are hexavalent chromium, strontium-90, and tritium. Selected samples also will be analyzed for additional constituents, including anions, metals, gross alpha, gross beta, and technetium-99.

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1.0 Introduction

The 100-B/C Operable Unit comprises the groundwater beneath the 100-B/C Area of the Hanford Site. The 100-B/C Area housed two of the nine nuclear reactors on the Hanford Site involved in the production of plutonium.

Groundwater monitoring at the 100-B/C Area began during reactor operations and focused on relatively few chemical and radiological constituents. Groundwater monitoring continued in the early 1990s under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA; 40 CFR 300, Subpart E). Additional monitoring wells were installed as part of a limited field investigation (DOE 1994) to determine the nature and extent of contamination in groundwater.

The objective of this sampling and analysis plan is to bridge the gap between data obtained from earlier investigations and the information required to support remedial action decisions (e.g., groundwater data may be input to risk assessment models). This revision refines the monitoring network (wells, aquifer sampling tubes, and springs), constituents, and schedule based on results of data collected under previous plans. As in the previous plan, this document describes an integrated monitoring program that meet the objectives of CERCLA and the *Atomic Energy Act of 1954* (AEA). However, AEA information is provided for completeness and to fully integrate monitoring. Monitoring for contaminants under the AEA is implemented under DOE Order 450.1.

The 100-BC-5 Operable Unit includes the groundwater beneath the 100-B/C Area and adjacent regions into which groundwater affected by operations in the 100-B Area may have migrated, including the Columbia River shoreline. The groundwater in the 100-BC-5 Operable Unit has been affected by past-practice discharge of liquid effluents to waste disposal facilities such as trenches, cribs, and retention basins. The groundwater operable unit does not include the waste disposal facilities and underlying vadose zone, which are associated with source operable units.

The Groundwater Performance Assessment project (groundwater project) has defined a series of "groundwater interest areas" (Figure 1) within the Hanford Site for purposes of (a) interpreting all groundwater data comprehensively and (b) scheduling and sampling efficiently. Consequently, this sampling and analysis plan addresses an area larger than the operable unit, termed the 100-BC-5 groundwater interest area. The interest area extends westward from the 100-B/C Area to the boundary of the Hanford Site, and eastward to the boundaries of the 100-KR-4 and 200-BP-5 groundwater interest areas. The eastern part of the 100-BC-5 groundwater interest area is affected by groundwater contamination that moved northward from the 200-East Area.

1.1 Background

Waste disposal and leakage contaminated the vadose zone and groundwater in the 100-B/C Area during the operational lifespan of B Reactor (1944-1968) and C Reactor (1952-1969). The operational history of the B and C Reactors, and their associated liquid and solid waste disposal sites, is presented in the *100-B Area Technical Baseline Report* (Carpenter et al. 1994). Waste stream categories identified in

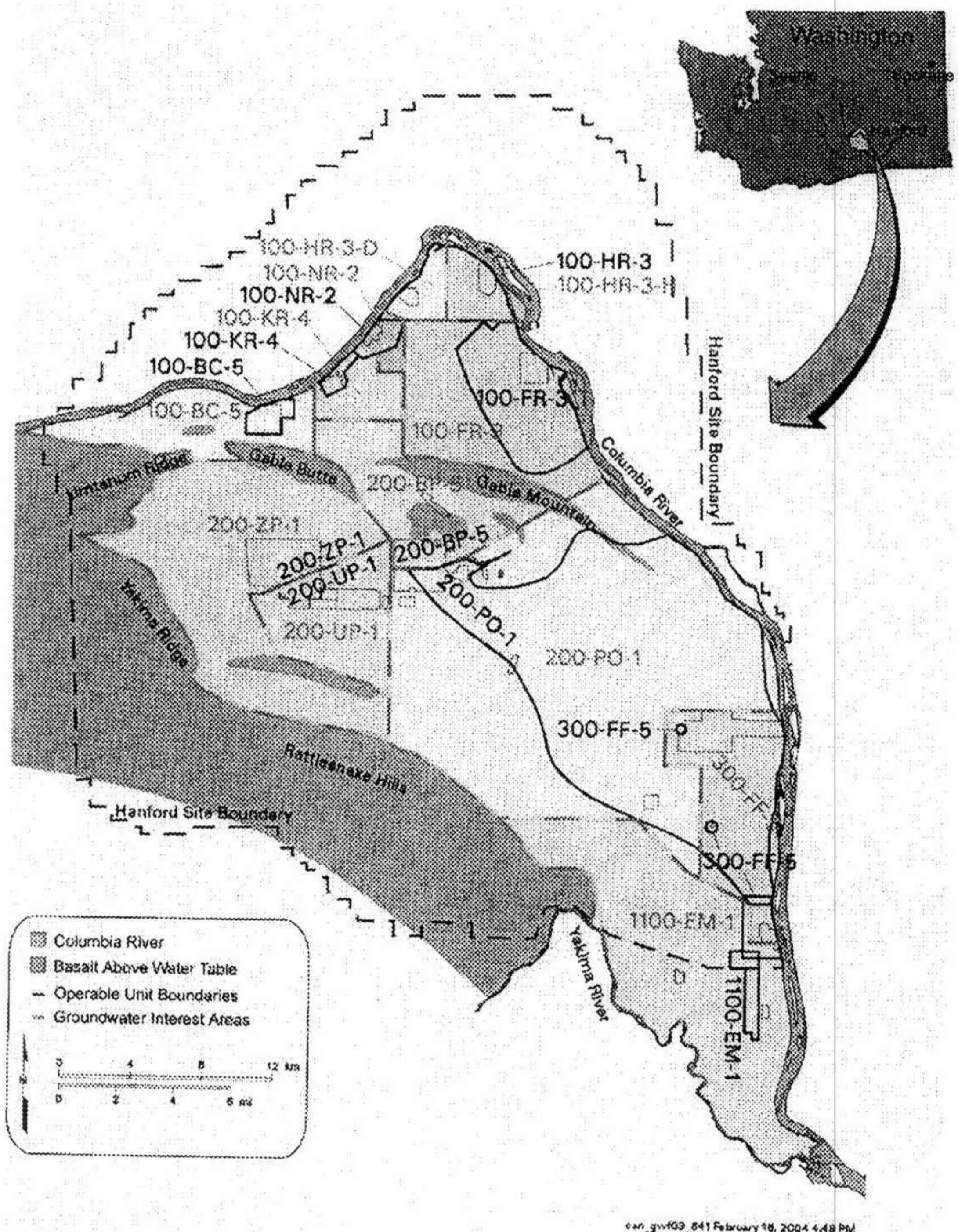

Figure 1. Groundwater Operable Units and Groundwater Interest Areas on the Hanford Site

the *Remedial Investigation/Feasibility Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland, Washington* (DOE 1992) include the following:

- Reactor process liquid waste and cooling water effluent
- Radioactive sludge/solid waste
- Reactor ventilation systems and inert gas system waste
- Tritium recovery facility waste
- Sanitary liquid waste
- Non-radioactive liquid waste
- Non-radioactive solid waste

The single-pass design of the cooling system used in the B and C Reactors meant that treated Columbia River water passed through the reactors, into large retention basins for a short period, and was then discharged to the river via outfall pipes and spillways. Used coolant was held in the retention basins for several hours to allow the temperature to decrease and for short-lived radionuclides to decay, thus reducing negative impacts to the river's ecosystem. Occasional fuel element ruptures in the reactor would cause the coolant to become highly contaminated with long-lived radionuclides. When this occurred, the used coolant was diverted to a liquid waste disposal trench for infiltration into the soil column, rather than being discharged directly to the river. The timing of liquid discharges to ground was often based on the type of discharge. Condensate from process systems and septic systems, for example, were generally discharged on a continuous basis, whereas discharges from highly radioactive sources were sporadic and often followed an event such as the rupture of fuel cladding in the reactor.

The CERCLA source areas that contribute to groundwater contamination are the surface and subsurface storage and disposal facilities that were associated with the operations at the 100-B/C Area. Many of these structures and their ancillary systems have been remediated. The facilities, waste sites, and unplanned release sites are listed in the technical baseline report (Carpenter et al. 1994) and in the *Remedial Investigation/Feasibility Work Plan for the 100-BC-5 Operable Unit* (DOE 1992):

- 116-B-11 and 116-C-5 cooling water retention basins (and associated piping and sludge burial trenches)

- 116-B-1 and 116-C-1 liquid waste disposal trenches

- Three outfall structures at the Columbia River north of the retention basis and trenches

- Two "pluto" cribs (116-B-3 and 116-C-2) near the two reactors for disposal of highly contaminated liquid wastes

- Eight cribs, trenches, and French drains near the B Reactor used for liquid waste disposal

- Reactor buildings, which housed fuel storage areas and exhaust stacks

- Eight radioactive solid waste burial sites

- Eight non-radioactive solid waste sites
- Nine septic tanks and associated leach fields

The cribs, trenches, and leaking retention basins allowed radioactive and chemical contaminants to flow through the vadose zone and reach groundwater. After the reactors were shut down, some of the waste sites continued to provide a source of groundwater contamination as less-mobile constituents migrated slowly through the vadose zone to reach groundwater. Recharge from natural precipitation and the effects of bank storage from the Columbia River alter the concentration of contaminants entering groundwater.

1.2 Contaminants of Concern

Contaminants of concern for the 100-BC-5 Operable Unit are hexavalent chromium, strontium-90, and tritium.[1] These contaminants were identified using information from the *Limited Field Investigation for the 100-BC-5 Operable Unit* (DOE 1994) and groundwater sampling results, as described in the data quality objectives report (Sweeney and Chou 2003) and the previous version of this sampling and analysis plan (DOE 2003). Strontium-90 and tritium exceed primary drinking water standards in some wells.

Concentrations of hexavalent chromium have remained below the 100-µg/L drinking water at all monitoring wells and aquifer tubes in recent years. However, concentrations exceed the 10-µg/L Water Quality Standard for Surface Waters of the State of Washington at some sampling locations, and chromium will continue to be monitored as a contaminant of concern.

1.3 Data Quality Objectives

In 2003, Pacific Northwest National Laboratory (PNNL) conducted a data quality objectives planning process for the 100-BC-5 and 100-FR-3 Operable Units, following *Guidance for the Data Quality Objectives Process* (EPA/600/R-96/055, QA/G-4, 2000, as revised). The results of that process were documented in *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring and Assessment Network for the 100-BC-5 and 100-FR-3 Operable Units* (Sweeney and Chou 2003). As described in Sweeney and Chou (2003), the data quality objectives process for the 100-BC-5 and 100-FR-3 Operable Units established a framework to answer the following questions:

- Are representative samples of an aquifer with a fluctuating water-table elevation being obtained?
- Are the constituents monitored necessary and sufficient?

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[1] The previous plan (Rev. 0) erroneously listed nitrate as a contaminant of concern for the 100-BC-5 Operable Unit. The data quality objectives document (PNNL-14287) did not identify nitrate as a contaminant of concern for this operable unit.

- Is the monitoring network adequate for purposes of tracking constituents that have potential human and other ecosystem impacts?

- Does the sampling frequency need to be revised for tracking plume movement?

The result of the data quality objectives process for the 100-BC-5 Operable Unit provided the basis for the monitoring network and design.

1.4 Changes from the Previous Plan

This document revises the previous sampling and analysis plan (DOE 2003), which was published in September 2003. While the overall approach to monitoring remains the same, sampling frequency and constituents have been modified in some wells to reflect data collected and evaluated after publication of the first plan. For example, if concentrations trends of the contaminants of concern were low and steady or declining, the sampling frequency was reduced from annual to biennial. Details and justification for the changes are given in Appendix A. Before September 2003, groundwater sampling in the 100-BC-5 Operable Unit was defined in Tri-Party Agreement Change Control Forms (Table 1).

Table 1. Monitoring Documents for the 100-BC-5 Operable Units

Monitoring Document (listed in order of most to least recent)	Comments
100-BC-5 Operable Unit Sampling and Analysis Plan (this document)	Update to Rev. 0.
100-BC-5 Operable Unit Sampling and Analysis Plan (DOE 2003; 09/2003)	Superceded previous monitoring documents; implemented results of data quality objectives process.
Groundwater Sampling and Analysis Plan for the 100-BC-5 Operable Unit (Sweeney 2000, 9/2000); also Federal Facility Agreement and Consent Order Change Control Form M-15-00-07 (12/19/2000)	Eliminated a well that was slated for decommissioning.
Federal Facility Agreement and Consent Order Change Control Form M-15-99-03 (07/14/1999)	Formalized deletion of certain wells and constituents that were not needed; eliminated wells that had been decommissioned.
Federal Facility Agreement and Consent Order Change Control Form M-15-96-07 (07/31/1996)	Reduced frequency for many wells/constituents following results from limited field investigation (DOE 1994).
100 NPL Agreement/Change Control Form 14 (06/18/1992)	Presented original network to be sampled for extensive constituent list quarterly, as part of initial remedial investigation.

The previous plan proposed the installation of aquifer sampling tubes (aquifer tubes) at six locations to supplement the existing aquifer tube network along the river shoreline. The new aquifer tubes were installed as planned. This revised plan includes monitoring aquifer tubes at a total of 14 locations along the 100-B/C Area shoreline.

The previous plan called for vertical sampling of wells 199-B3-46 and 199-B3-47 for one year with a special sampling assembly to assess the distribution of contaminants with depth. At the time of preparation of this plan, vertical sampling work had not been completed, but is still planned. If results show significant vertical variability that warrants special sampling techniques (e.g., sampling from a specific hydrogeologic horizon), this sampling and analysis plan will be revised.

Contaminant concentrations in aquifer tubes are generally highest in mid-or deep-level tubes because the shallow tubes are more heavily diluted by river water. Strontium-90, however, generally is detected at lower concentrations in the deep tubes than in shallow or mid-level tubes in the 100-B/C Area because it is less mobile than other contaminants and stays near the top of the aquifer. For this reason, it is advisable to collect samples for strontium-90 analysis from multiple depths at selected aquifer tube locations.

2.0 Field Sampling Plan

This section lists the wells, aquifer tubes, and shoreline springs to be monitored, and the sampling frequency and constituents. Protocol for sampling, analysis, and related activities are summarized.

2.1 Sampling Objectives

The primary objective of groundwater monitoring in the 100-BC-5 Operable Unit is to provide information to support selection of a final remedy for the operable unit, including concentrations and flux of hexavalent chromium, strontium-90, and tritium to the Columbia River through the aquifer. Secondary objectives are (a) to define the extent of contamination in the aquifer, (b) track concentration trends near former waste sites, and (c) provide information on groundwater quality and flow in the larger 100-BC-5 groundwater interest area.

2.2 Sampling Locations and Frequency

The 100-BC-5 monitoring network is designed to focus on the portion of the aquifer that discharges to the Columbia River, as monitored by the aquifer tubes. Monitoring wells farther inland provide data on contaminant concentrations closer to their sources. The groundwater wells, springs, and aquifer tubes to be sampled in support of the 100-BC-5 Operable Unit are listed in Table 2 and are shown in Figures 2 and 3. The table also includes constituents to be monitored and frequency of sampling, which ranges from annual to biennial. Samples are to be collected in accordance with the procedures described in Section 2.5.

Appendix A notes where the current wells or sampling frequency have changed from the previous sampling and analysis plan and provides rationale for those changes. Groundwater project staff developed the sampling matrix in conjunction with the U.S. Department of Energy (DOE) and Environmental Protection Agency (EPA). Wells 199-B4-5 and 199-B4-6 will not be sampled under this revised plan, but are retained in the well list of Table 2 for water levels and potential future use (e.g., sampling, aquifer testing).

Table 2. Groundwater Sampling Matrix for the 100-BC-5 Operable Unit

Well ID	Well, Aquifer Tube, or Spring	Status	WAC Compliant	Contaminants of Concern				Supporting Constituents									
				Chromium (hexavalent)	Chromium (total, filtered)	Strontium-90	Tritium	Specific Conductance[a]	Temperature[a]	Turbidity[a]	Water Level[a]	Alkalinity	Anions[b]	Metals (filtered)[c]	Gross Alpha	Gross Beta	Technetium-99
Wells																	
A4550	199-B2-12	Active	C		BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	
A4551	199-B2-13	Active	C		A	BE	BE	A	A	A	A	A	A	A	BE	BE	
A4552	199-B3-1	Active	N	A	A	A	A	A	A	A	A	A	A	A			
A4553	199-B3-46	Active	C	A	BO	A	A	A	A	A	A	BO	BO	BO			
A4554	199-B3-47	Active	C	A	A	A	A	A	A	A	A	A	A	A	A	A	
A4555	199-B4-1	Active	N	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	
A4557	199-B4-4	Active	N			BE	BE	BE	BE	BE	BE				BE	BE	
A5540	199-B4-5	Reserve	C								A						
A4558	199-B4-6	Reserve	C								A						
A5541	199-B4-7	Active	C		BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	
A4559	199-B4-8	Active	C		A	BE	BE	A	A	A	A	A	A	A	BE	BE	
A4561	199-B5-1	Active	N	A	A	BE	A	A	A	A	A	A	A	A	A	A	
A4562	199-B5-2	Active	C	A		BO	A	A	A	A	A				BO	BO	
A4563	199-B8-6	Active	C		BO	BO	A	A	A	A	A	BO	BO	BO	BO	BO	
A4565	199-B9-2	Active	C			BE	BE	BE	BE	BE	BE				BE	BE	
A4566	199-B9-3	Active	C		BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	BO	
A5293	699-63-90	Active	N		BE		BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	
A5302	699-65-72	Active	N		BE		BE	BE	BE	BE	BE	BE	BE	BE			
A5303	699-65-83	Active	N				BE	BE	BE	BE	BE						

Table 2. (contd)

Well ID	Well, Aquifer Tube, or Spring	Status	WAC Compliant	Contaminants of Concern				Supporting Constituents									
				Chromium (hexavalent)	Chromium (total, filtered)	Strontium-90	Tritium	Specific Conductance[a]	Temperature[a]	Turbidity[a]	Water Level[a]	Alkalinity	Anions[b]	Metals (filtered)[c]	Gross Alpha	Gross Beta	Technetium-99
A5305	699-66-103	Active	N				BE	BE	BE	BE	BE						
A5313	699-67-86	Active	N				BO	BO	BO	BO	BO						
A5315	699-68-105	Active	N		BO		BO	BO	BO	BO	BO	BO	BO	BO			
A5322	699-71-77	Active	N		BO		BO	BO	BO	BO	BO	BO	BO	BO			BO
A5323	699-72-73	Active	N		A		A	A	A	A	A	A	A	A			BO
A5325	699-72-92	Active	N		BO		BO	BO	BO	BO	BO	BO	BO	BO			
Aquifer Tubes[d]																	
B8115,14	01 (S,M)	Active	NA	A			A	A	A	A	A						
B8120, 19	03 (M,D)	Active	NA	A			A	A	A	A	A						
C4375	AT-B-1 (M)	Active	NA	A			A	A	A	A	A						
C4378, 79, 77	AT-B-2 (S,M,D)	Active	NA	A			A	A	A	A	A						
B8124, 23, 22	04 (S,M,D)	Active	NA	A			A	A	A	A	A		A				
B8127, 26, 25	05 (S,M,D)	Active	NA	A		A	A	A	A	A	A		A		A	A	
C4382, 81, 80	AT-B-3 (S,M,D)	Active	NA	A		A	A	A	A	A	A		A		A	A	
B8130, 29, 28	06 (S,M,D)	Active	NA	A		A	A	A	A	A	A		A		A	A	
B8131	07 (D)	Active	NA	A			A	A	A	A	A		A		A	A	
C4368	AT-B-4 (S)	Active	NA	A			A	A	A	A	A		A		A	A	
C4371, 70, 69	AT-B-7 (S,M,D)	Active	NA	A		A	A	A	A	A	A		A		A	A	
C4374, 73, 72	AT-B-5 (S,M,D)	Active	NA	A		A	A	A	A	A	A		A		A	A	A
B8143	11 (D)	Active	NA	A			A	A	A	A	A				A	A	A
B8146	12 (D)	Active	NA	A			A	A	A	A	A				A	A	A

Table 2. (contd)

Well ID	Well, Aquifer Tube, or Spring	Status	WAC Compliant	Contaminants of Concern				Supporting Constituents									
				Chromium (hexavalent)	Chromium (total, filtered)	Strontium-90	Tritium	Specific Conductance[a]	Temperature[a]	Turbidity[a]	Water Level[a]	Alkalinity	Anions[b]	Metals (filtered)[c]	Gross Alpha	Gross Beta	Technetium-99
Springs[e]																	
NA	037-1	Active	NA	A			A	A	A	A	A				A	A	
NA	039-2	Active	NA	A			A	A	A	A	A				A	A	
NA	Other springs[f]	Possible	NA	A	A		A	A	A	A	A	A	A	A	A	A	

(a) Field measurement.
(b) Anions - Analytes include but not limited to chloride, nitrate, and sulfate.
(c) Metals - Analytes include but not limited to calcium, potassium, magnesium, and sodium.
(d) Aquifer tube sites may include multiple depths: deep (D), medium, (M), and shallow (S). Each aquifer tube will be sampled for field parameters if conditions permit. If specific conductance in at least one tube is >160 μS/cm, samplers will select the tube with the highest specific conductance for laboratory analyses. However, if strontium-90 is scheduled at a tube site, all tube depths will be analyzed for strontium-90, regardless of the specific conductance result.
(e) Springs sampled if specific conductance is greater than river water.
(f) Springs are not always constant from year to year. Samplers may elect to collect samples from other springs at their discretion.

A = To be sampled annually.
BE = To be sampled biennially in even-numbered fiscal years (e.g., fiscal year 2006).
BO = To be sampled biennially in odd-numbered fiscal years (e.g., fiscal year 2005).
C = Well is constructed as a WAC 173-160, Part Two resource protection well.
N = Well construction is not compliant with WAC 173-160, Part Two resource protection requirements.
NA = Not applicable.

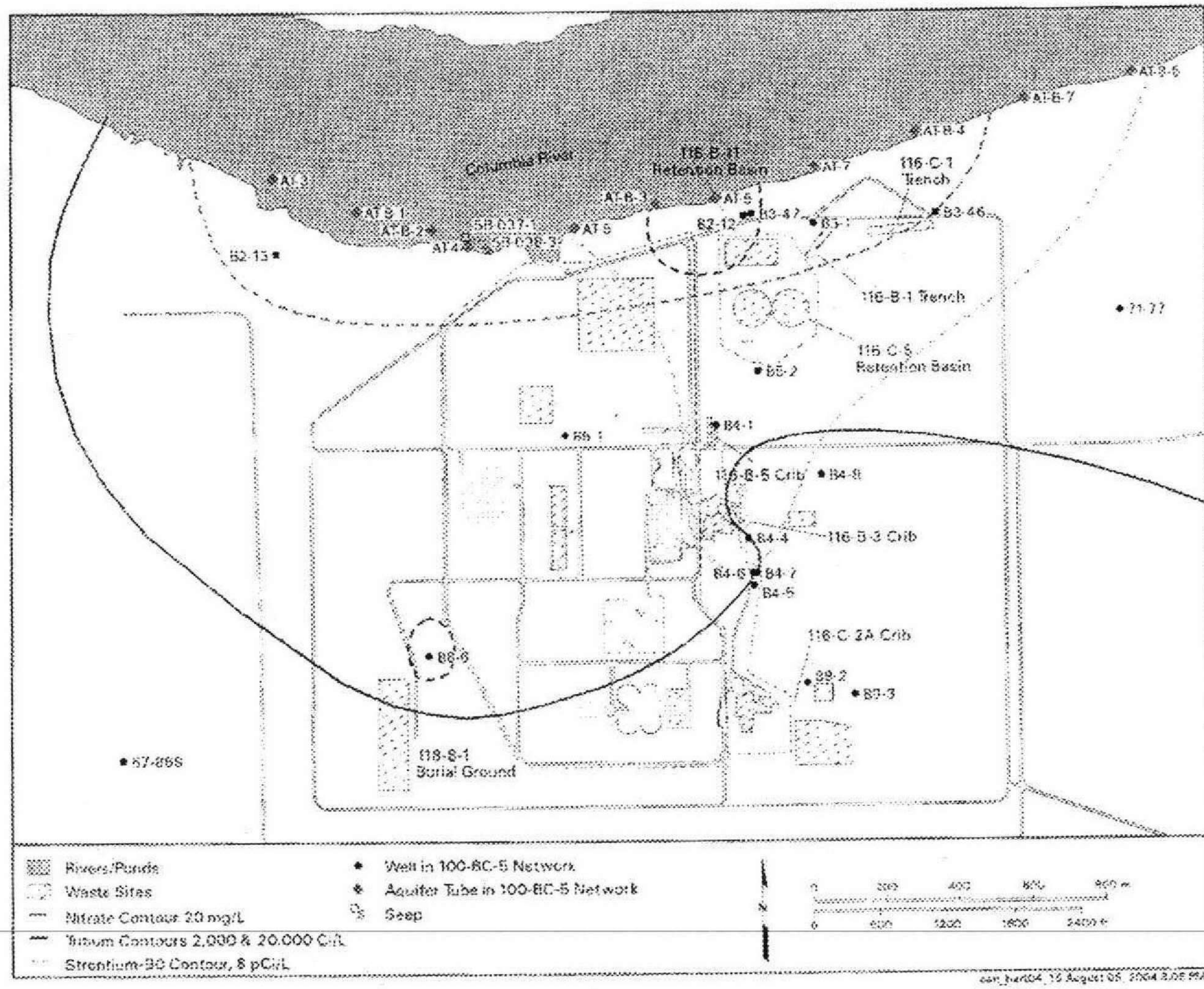

Figure 2. Wells, Aquifer Tubes, and Springs in the 100-B/C Area, With Groundwater Contaminant Plumes for Fiscal Year 2003

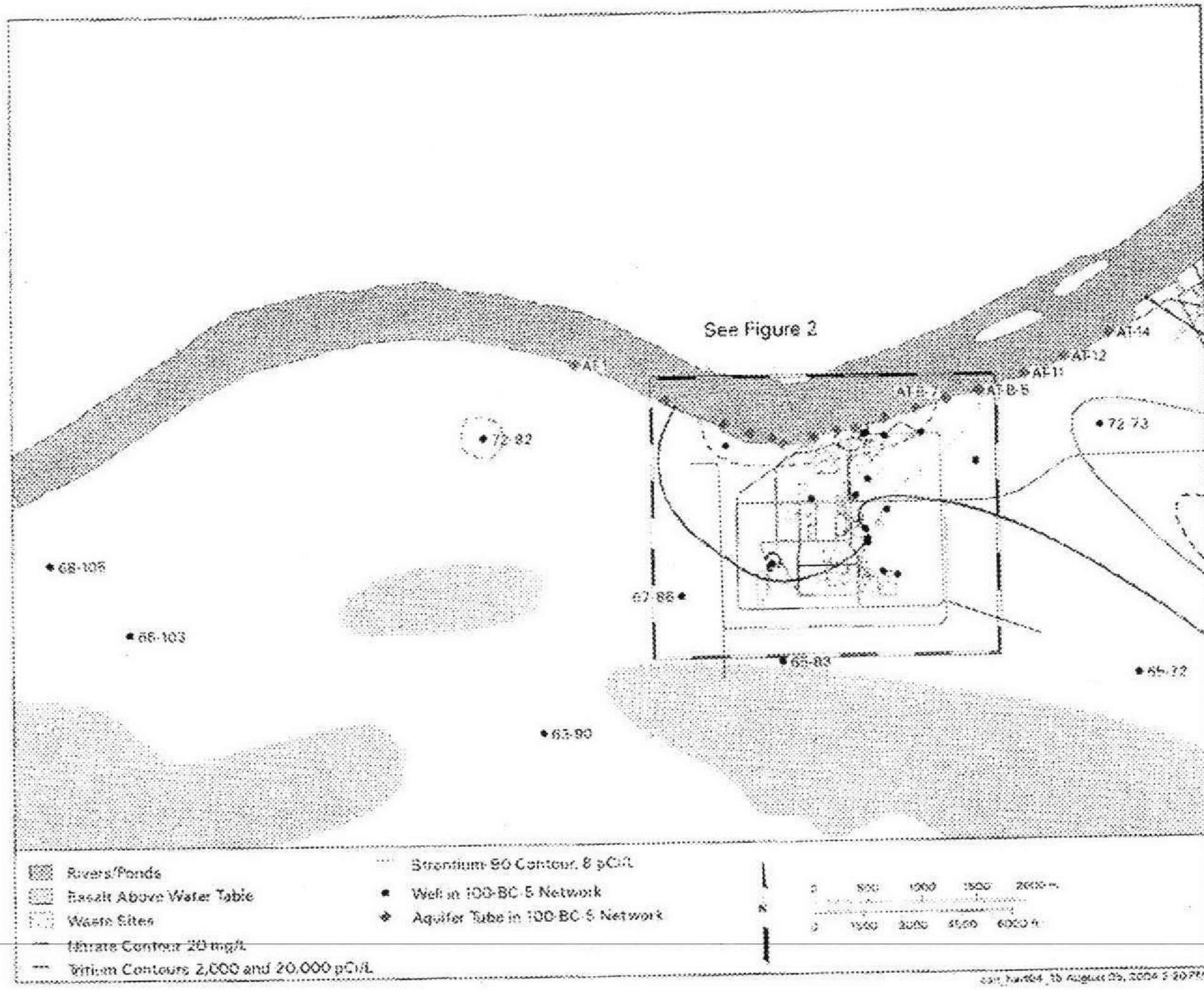

Figure 3. Wells, Aquifer Tubes, and Springs in the 600 Area Near the 100-B/C Area, With Groundwater Contaminant Plumes for Fiscal Year 2003

A typical aquifer tube site includes three tubes monitoring different depths: one just beneath the low river stage water table; a second near the bottom of the uppermost hydrologic unit; and the third at mid-depth between the other two ports. Field conditions may result in more or fewer tubes at a particular location. Specific conductance will be measured at each tube listed in Table 2. At each site, additional samples will be collected from the tube that is most representative of groundwater (generally the tube with highest specific conductance). If specific conductance is less than 160 μS/cm in all tubes, the site is considered not representative of groundwater and no samples are collected for additional analyses.

One exception to this general aquifer tube sampling procedure is for strontium-90. Where strontium-90 is scheduled at an aquifer tube site, samples will be collected from all tubes, regardless of the specific conductance results. Previous data from the 100-B/C Area indicate that strontium-90 concentrations are higher in shallow and mid-level tubes and are lower or undetectable in deep tubes. Therefore, it is desirable to obtain several years of data from multiple depths to confirm these trends.

2.3 Constituents to be Monitored

As stated in Section 1.2, the contaminants of concern for the 100-BC-5 Operable Unit are hexavalent chromium, strontium-90, and tritium. Tritium, the most mobile contaminant, will be analyzed in samples from all wells, aquifer tubes, and springs (see Table 2). Most samples are also analyzed for total or hexavalent chromium (total chromium in filtered samples represents hexavalent chromium). Strontium-90 will be monitored in locations selected based on historical detections of the contaminant.

In addition to the contaminants of concern, samples will be analyzed for supporting constituents, which include field parameters and, in some cases, anions, metals, alkalinity, gross alpha, gross beta, and technetium-99 (see Table 2). General chemical parameters such as specific conductance, anions, metals, and alkalinity can help determine the quality of the data as well as provide input to geochemical modeling. Gross alpha and gross beta provide general screening information to identify unexpected changes in radionuclide contaminant concentrations. Concentrations of nitrate are below the 45-mg/L drinking water standard but are above background in some wells in the northern 100-B/C Area and in groundwater flowing into the area from the southeast.

The choice of constituents to be monitored at each well or aquifer tube has been modified somewhat for this revision (see Appendix A). For example, technetium-99 has been added as a supporting constituent at a few sampling locations east of the 100-B/C Area to track the movement of a contaminant plume that originated in the 200-East Area. Tritium and nitrate are co-contaminants in that plume.

2.4 Water-Level Monitoring

Groundwater levels are monitored on the Hanford Site primarily to help determine the direction and rate of groundwater flow. This information is used to interpret contaminant plume movement and to predict future movement.

Static water levels are measured in the monitoring well prior to sampling, and a minimum of two consistent measurements are taken to confirm precision of the measurement. In addition, the groundwater project measures water levels across the Hanford Site annually to construct a site-wide water-table map.

A list of wells used for water-level measurements, criteria for their selection, hydrogeologic units monitored, and descriptions of the techniques used to collect the data are provided in *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project* (McDonald et al. 1999). The wells identified in McDonald et al. (1999) will be used for annual measurements for the 100-BC-5 Operable Unit. Samplers measure depth to groundwater according to a subcontractor's procedure. The depth to groundwater is subtracted from the elevation of a reference point (usually top of casing) to obtain the water-level elevation.

2.5 Sampling and Analysis Protocol

Groundwater monitoring for the 100-BC-5 Operable Unit is part of the groundwater project and follows the project's quality assurance plan, which is compliant with *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001, as revised). Groundwater monitoring will follow the requirements of the most recent revision of the quality assurance project plan; this monitoring plan need not be revised to cite future revisions of the quality assurance plan.

Project staff schedule sampling and initiate paperwork. The project uses subcontractors for sample collection, shipping, and analysis. Quality requirements for the subcontracted work are specified in statements of work or contracts.

The statement of work for sampling activities specifies that activities shall be in accordance with a quality assurance project plan that meets the requirements defined in *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001, as revised). Additional requirements are specified in the statement of work.

Groundwater project staff conduct laboratory audits and field surveillances to assess the quality of subcontracted work and initiate corrective action if needed.

The current controlling document for the aquifer tube task is the *Sampling and Analysis Plan for Aquifer Sampling Tubes* (DOE 2000). In order to foster consistency in aquifer tube sampling, procedures and methods will be emphasized in the DOE (2000).

Riverbanks springs are sampled annually during the fall months and in conjunction with spring sampling conducted under the Surface Environmental Surveillance Project at PNNL.

2.5.1 Scheduling Groundwater Sampling

The groundwater project has the responsibility for scheduling well sampling. Many Hanford Site wells are sampled for multiple objectives and requirements. Scheduling activities help manage the overlap, eliminating redundant sampling, and meeting the needs of each sampling objective.

2.5.2 Chain of Custody

PNNL and the well sampling subcontractor use chain-of-custody procedures and documentation that are consistent with *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA

QA/R-5, March 2001, as revised). Use of these protocols documents the integrity of groundwater samples from the time of collection through data reporting. The forms are generated during scheduling (see Section 2.5.1) and managed by the samplers.

2.5.3 Sample Collection

Groundwater samples are collected as described in a subcontractor procedure. Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized (i.e., after two consecutive measurements are within 0.2 units pH, 0.2°C for temperature, 10% for specific conductance, and turbidity <5 Nephelometric Turbidity Units [NTU]). For routine groundwater samples, preservatives are added to the collection bottles before their use in the field. Samples to be analyzed for metals are usually filtered in the field so that results represent dissolved metals.

2.5.4 Analytical Protocols

Procedures for field measurements are specified in subcontractor's procedures. Each instrument is assigned a unique number that is tracked on field documentation and is calibrated and controlled according to procedure. Additional calibration and use instructions are specified in the instrument user's manuals.

Laboratory analytical methods are specified in contracts with the laboratories, and are standard methods from *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA SW-86, 1986, as revised) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, 1979, as revised).

3.0 Quality Assurance

Groundwater Performance Assessment Project Quality Assurance Plan is compliant with *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001, as revised). A quality control plan is included in the groundwater project quality assurance plan, and quality control sampling requirements for subcontracted work are discussed in a statement of work.

The groundwater project's quality control program is designed to assess and enhance the reliability and validity of groundwater data. This is accomplished through evaluating the results of quality control samples, conducting audits, and validating groundwater data. This section describes the quality control program for the entire groundwater project, which includes the 100-BC-5 Operable Unit. The quality control practices of the groundwater project are compliant with the *Tri-Party Agreement* (Ecology et al. 1989, as amended), Section 7.8. Accuracy, precision, and detection are the primary parameters used to assess data. Data for these parameters are obtained from two categories of quality control samples: those that provide checks on field and laboratory activities (field quality control) and those that monitor laboratory performance (laboratory quality control). Table 3 summarizes the types of samples in each category and the sample frequencies and characteristics evaluated.

Table 3. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
	Field Quality Control	
Full Trip Blank	Contamination from containers or transportation	1 per 20 well trips
Field Transfer Blank	Airborne contamination from the sampling site	1 each day volatile organic compound samples are collected
Equipment Blank	Contamination from non-dedicated sampling equipment	1 per 10 well trips or as needed[(a)]
Duplicate Samples	Reproducibility	1 per 20 well trips
	Laboratory Quality Control	
Method Blank	Laboratory contamination	1 per batch
Lab Duplicates	Laboratory reproducibility	Method/contract specific[(b)]
Matrix Spike	Matrix effects and laboratory accuracy	Method/contract specific[(b)]
Matrix Spike Duplicate	Laboratory reproducibility and accuracy	Method/contract specific[(b)]
Surrogates	Recovery/yield	Method/contract specific[(b)]
Laboratory Control Sample	Accuracy	1 per batch
Double Blind Standards	Accuracy and precision	Varies by constituent[(c)]

(a) When a new type of non-dedicated sampling equipment is used, an equipment blank should be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the equipment's decontamination procedure.
(b) If called for by the analytical method, duplicates, matrix spikes, and matrix spike duplicates are typically analyzed at a frequency of 1 per 20 samples. Surrogates are routinely included in every sample for most gas chromatographic methods.
(c) Double blind standards containing known concentrations of selected analytes are typically submitted in triplicate or quadruplicate on a quarterly, semi-annual, or annual basis.

3.1 Quality Control Criteria

Quality control data are evaluated based on established acceptance criteria for each quality control sample type. For field and method blanks, the acceptance limit is generally two times the instrument detection limit (metals), method detection limit (other chemical parameters), or minimum detectable activity (radiochemistry parameters). However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and phthalate esters, the limit is five times the method detection limit. Groundwater samples that are associated (i.e., collected on the same date and analyzed by the same method) with out-of-limit field blanks are flagged with a "Q" in the database to indicate a potential contamination problem.

Field duplicates must agree within 20%, as measured by the relative percent difference (RPD), to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Unacceptable field duplicate results are also flagged with a "Q" in the database.

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are generally derived from historical data at the laboratories in accordance with *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA SW-846, 1986, as revised). Typical acceptance limits are within 25% of the expected values, although the limits may vary considerably with the method and analyte. For radiological analyses, the acceptance limits for laboratory quality control samples are specified in the laboratory contract. Current values for laboratory duplicates, matrix spikes, and laboratory control samples are 20% RPD, 60%-140%, and 70%-130%, respectively. These values are subject to change if the contract is modified or replaced.

Table 4 lists the acceptable recovery limits for the double blind standards. These samples are prepared by spiking background well water (currently wells 699-19-88 and 699-49-100C) with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Double blind standard results that are outside the acceptance limits are investigated and appropriate actions are taken if necessary.

Table 4. Recovery Limits for Double Blind Standards

Constituent	Frequency	Recovery Limits	Precision Limits (RSD)
Specific conductance	Quarterly	75%–125%	25%
Fluoride	Quarterly	75%–125%	25%
Nitrate	Quarterly	75%–125%	25%
Chromium	Annually	80%–120%	20%
Carbon tetrachloride	Quarterly	75%–125%	25%
Chloroform	Quarterly	75%–125%	25%
Trichloroethene	Quarterly	75%–125%	25%
Gross alpha[(a)]	Quarterly	70%–130%	20%
Gross beta[(b)]	Quarterly	70%–130%	20%
Tritium	Annually	70%–130%	20%
Strontium-90	Semiannually	70%–130%	20%

(a) Gross alpha standards will be spiked with plutonium-239.
(b) Gross beta standards will be spiked with strontium-90.
RSD = Relative Standard Deviation.

Holding time is the elapsed time period between sample collection and analysis. Exceeding recommended holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA SW-86, 1986, as revised) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, 1979, as revised). Holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged with an "H" in the Hanford Environmental Information System (HEIS) database.

Additional quality control measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies. The groundwater project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

3.2 Groundwater Data Validation Process

The groundwater project's data validation process provides requirements and guidance for validation of groundwater data that are routinely collected as part of the groundwater project. Validation is a systematic process of reviewing data against a set of criteria to determine whether the data are acceptable for their intended use. This process applies to groundwater data that have been verified (see Section 4.1) and loaded into the Hanford Environmental Information System database (HEIS). The outcome of the activities described below is an electronic data set with suspect or erroneous data corrected or flagged.

Responsibilities for data validation are divided among project staff. Each groundwater interest area is assigned to a project scientist, who is familiar with the hydrogeologic conditions of that area. The data validation process includes the following elements.

- **Generation of Data Reports.** Twice each month, data management staff provide tables of newly loaded data to project scientists for evaluation (biweekly reports). Also, after laboratory results from a reporting quarter have been loaded into HEIS, staff produce tables of water-level data and analytical data for wells sampled within that quarter (quarterly reports). The quarterly data reports include any data flags added during the quality control evaluation or as a result of prior data review.

- **Project Scientist Evaluation.** As soon as practical after receiving biweekly reports, project scientists review the data to identify changes in groundwater quality or potential data errors. Evaluation techniques include comparing key constituents to historical trends or spatial patterns. Other data checks may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions) and calculation of charge balances. Project scientists request data reviews if appropriate (see Section 4.2). If necessary, the laboratory may be asked to check calculations or reanalyze the sample, or the well may be resampled. After receiving quarterly reports, project scientists review sampling summary tables to determine whether network wells were sampled and analyzed as scheduled. If not, they work with other project staff to resolve the problem. Project scientists also review quarterly reports of analytical and water-level data using the same techniques as for biweekly reports. Unlike the biweekly reports, the quarterly reports usually include a full data set (i.e., all the data from the wells sampled during the previous quarter have been received and loaded into HEIS).

- Staff report results of quality control evaluations informally to project staff, DOE, and Washington State Department of Ecology each quarter; DOE will provide them to EPA on request. Results for each fiscal year are described in the annual groundwater monitoring report.

4.0 Data Management, Evaluation, and Reporting

This section describes how groundwater data are stored, retrieved, and interpreted.

4.1 Loading and Verifying Data

The contract laboratories report analytical results electronically and in hard copy. The electronic results are loaded into HEIS. Hard copy data reports and field records are maintained as part of the Tri-Party Agreement administrative record. Project staff perform an array of computer checks on the electronic file for formatting, allowed values, data flagging (qualifiers), and completeness. Verification of the hard copy results includes checks for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems that arose during the analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to get the problems corrected. Notes on condition of samples or problems during analysis may be used to support data reviews (see Section 4.2).

Field data such as specific conductance, pH, temperature, turbidity, and depth-to-water are recorded on field records. Data management staff enter these into HEIS manually through data-entry screens, verify each value against the hard copy, and initial each value on the hard copy.

4.2 Data Review

The groundwater project conducts special reviews of groundwater analytical data or field measurements when results are in question. Groundwater project staff document the process on a review form, and results are used to flag the data appropriately in HEIS. Various staff may initiate a review form: e.g., project scientists, data management staff, and quality control staff. A project scientist assigned to examine review forms determines and records the appropriate response and action on the review form, including changes to be made to the data flags in HEIS. Actions may include updating HEIS with corrected data or result of reanalysis, flagging existing data (e.g., "R" for reject, "Y" for suspect, "G" for good), and/or adding comments. Data management staff updates the temporary "F" flag to the final flag in HEIS.

4.3 Interpretation

After data are validated and verified, the acceptable data are used to interpret groundwater conditions at the site. Interpretive techniques include:

- Hydrographs – graph water levels vs. time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.

- Water-table maps – use water-table elevations from multiple wells to construct contour maps to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.

- Trend plots – graph concentrations of constituents vs. time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water-table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.

- Plume maps – map distributions of chemical or radiological constituents in the aquifer to determine extent of contamination. Changes in plume distribution over time aid in determining movement of plumes and direction of flow.

- Contaminant ratios – can sometimes be used to distinguish between different sources of contamination.

4.4 Reporting

Chemistry and water-level data are reviewed after each sampling event and are available in HEIS.

Any unusual results for the 100-BC-5 Operable Unit will be summarized in letter reports or informal reports to EPA (e.g., reports via e-mail or presented at unit manager's meetings). Formal, interpretive groundwater reports for the entire Hanford Site are issued annually in March (e.g., *Hanford Site Groundwater Monitoring for Fiscal Year 2003*, Hartman et al. 2004).

4.5 Change Control

The approach to making changes in 100-BC-5 Operable Unit monitoring activities, associated documents, and approval requirements are listed in Table 5.

Table 5. Change Control for Groundwater Monitoring in the 100-BC-5 Operable Unit

Type of Change	Action	Documentation
Temporarily (≤1 year) adding constituents, wells, or increasing sampling frequency	Project management approval; notify regulator if appropriate	Project's schedule tracking system.
Permanently (>1 year) adding constituents, wells, or increasing sampling frequency	Revise sampling and analysis plan	Revised plan.
Deleting constituents or wells; decreasing frequency	Obtain regulator approval prior to change.	Initial approval may be verbal or e-mail. Formal approval via letter or signed meeting minutes.
Unavoidable changes (e.g., dry wells; delayed samples, one-time missed samples due to broken pump, lost bottle, etc.)	Notify regulator.	Project's schedule tracking system; notification via letter, report, e-mail, or meeting minutes.
Revision to sampling and analysis plan	Revise plan; obtain regulator approval; distribute plan.	Revised plan.

5.0 Health and Safety

All field operations will be performed consistent with PNNL health and safety requirements as described in PNNL's online Systems Based Management System. For work performed by other contractors, these standards are implemented via subcontracts and work orders.

Where necessary, work planning packages will include, as appropriate, a job hazard analysis, and/or a site-specific health and safety plan, and applicable radiological permits.

The sampling procedures and associated activities will implement as low as reasonably achievable practices to minimize the radiation exposure to the sampling team, consistent with the requirements outlined in accepted PNNL procedures.

6.0 References

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Appendix A

Changes to Field Sampling Plans in Rev. 0 and Rev. 1

Appendix A

Changes to Field Sampling Plans in Rev. 0 and Rev. 1

Table A.1 lists wells, aquifer tubes, and springs in the revised and previous monitoring networks, summarizes changes to the monitoring program, and provides justification for those changes.

Table A.1. Comparison of Revised and Previous Monitoring Networks for 100-BC-5 Operable Unit

Well, Aquifer Tube, or Spring	Alkalinity	Anions (NO_3)	Alpha/Beta	Hexavalent Chromium	Metals	Strontium-90	Tritium	Proposed Changes from Rev. 0 Sampling and Analysis Plan	Justification for Change
199-B2-12	BO	BO	BO	xx	BO	BO	BO	Decrease frequency to biennial	Deep well; CoCs are low and stable
199-B2-13	A	A	BE	xx	A	BE	BE	Decrease frequency of tritium to biennial	West of B Area; tritium declining
199-B3-1	A	A	xx	A	A	A	A	Add metals	Provides general chemistry information
199-B3-46	BO	BO	xx	A	BO	A	A	Add anions and metals biennially	Provides general chemistry information
199-B3-47	A	A	A	A	A	A	A	Add metals	Provides general chemistry information
199-B4-1	BE	BE	BE	BE	BE	BE	BE	Add chromium biennially; anions and metals	Chromium increased in 1990s (<DWS): general chemistry
199-B4-4	xx	xx	BE	xx	xx	BE	BE	No change	
199-B4-5	xx	xx	xx	xx	xx	xx	xx	Delete well from sampling; reserve for potential future use	B4-5, -6, and -7 all monitor same area and depth; only need one well.
199-B4-6	xx	xx	xx	xx	xx	xx	xx	Delete well from sampling; reserve for potential future use	B4-5, -6, and -7 all monitor same area and depth; only need one well.
199-B4-7	BO	BO	BO	xx	BO	BO	BO	Add anions and metals biennially	Provides general chemistry information
199-B4-8	A	A	BE	xx	A	BE	BE	Decrease frequency for alpha, beta, and tritium to biennial	CoCs are low and steady or declining
199-B5-1	A	A	A	A	A	BE	A	Add chromium annually; add anions and metals	Chromium variable and elevated, with peak >DWS
199-B5-2	xx	xx	BO	A	xx	BO	A	Decrease frequency for alpha and beta to biennial	Levels stable or declining; <DWS
199-B8-6	BO	BO	BO	xx	BO	BO	A	Increase frequency for tritium to annual; add anions and metals	Tritium has spiked in past; anions and metals for general chemistry
199-B9-2	xx	xx	BE	xx	xx	BE	BE	No change	
199-B9-3	BO	BO	BO	xx	BO	BO	BO	Add anions and metals biennially	Provides general chemistry information
699-63-90	BE	BE	BE	xx	BE	xx	BE	Decrease frequency to biennial; add anions and metals	CoCs are low and steady

Table A.1. (contd)

Well, Aquifer Tube, or Spring	Alkalinity	Anions (NO_3)	Alpha/Beta	Hexavalent Chromium	Metals	Strontium-90	Tritium	Proposed Changes from Rev. 0 Sampling and Analysis Plan	Justification for Change
699-65-72	BE	BE	xx	xx	BE	xx	BE	Decrease frequency to biennial	CoCs are low and steady
699-65-83	xx	xx	xx	xx	xx	xx	BE	No change	
699-66-103	xx	xx	xx	xx	xx	xx	BE	No change	
699-67-86	xx	xx	xx	xx	xx	xx	BO	No change	
699-68-105	BO	BO	xx	xx	BO	xx	BO	Add anions and metals	Provides general chemistry information
699-71-77	BO	BO	xx	xx	BO	xx	BO	Add anions, beta, metals, Tc-99	Monitor for 200 Areas plume
699-72-73	A	A	A	xx	A	xx	A	Add beta, metals, Tc-99	Monitor for 200 Areas plume; general chemistry
699-72-92	BO	BO	xx	xx	BO	xx	BO	Decrease frequency to biennial; add metals	CoCs are low and steady
1-S,M	xx	xx	xx	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume; all ND
3-M,D	xx	xx	xx	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume; all ND
AT-B-1-M	xx	xx	xx	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume
AT-B-2-S,M,D	xx	xx	xx	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume
4-S,M,D	xx	A	xx	A	xx	xx	A	Add anions; drop Sr-90	Nitrate elevated in past; upstream of Sr-90 plume
5-S,M,D	xx	A	A	A	xx	A	A	Add anions and beta; increase Sr-90 to annual	Look for 200-East plume; do all annually
AT-B-3-S,M,D	xx	A	A	A	xx	A	A	Add anions and beta; increase Sr-90 to annual	Look for 200-East plume; do all annually
6-S,M,D	xx	A	A	A	xx	A	A	Add anions and beta; increase Sr-90 to annual	Look for 200-East plume; do all annually
7-D	xx	A	A	A	xx	xx	A	Add anions and beta; drop Sr-90	Look for 200-East plume; Sr-90 ND in deep tube
AT-B-4-S	xx	A	A	A	xx	xx	A	Add anions and beta; increase Sr-90 to annual	Establish levels; do all annually
AT-B-7-S,M,D	xx	A	A	A	xx	A	A	Add anions and beta; increase Sr-90 to annual	Establish levels; do all annually
AT-B-5-S,M,D	xx	A	A	A	xx	A	A	Add anions, beta, Tc-99; increase Sr-90 to annual	Establish levels; do all annually

Table A.1. (contd)

Well, Aquifer Tube, or Spring	Alkalinity	Anions (NO_3)	Alpha/Beta	Hexavalent Chromium	Metals	Strontium-90	Tritium	Proposed Changes from Rev. 0 Sampling and Analysis Plan	Justification for Change
11-D	xx	xx	A	A	xx	xx	A	Add site; include Tc-99	Look for 200-East plume
12-D	xx	xx	A	A	xx	xx	A	Add site; include Tc-99	Look for 200-East plume
037-1	xx	xx	A	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume; all ND
039-2	xx	xx	A	A	xx	xx	A	Drop Sr-90	Upstream of Sr-90 plume; all ND
Other springs	A	A	A	A	A	xx	A	Add other springs if present, at discretion of samplers	Supporting data

A = Annually.
BE = Biennially in even fiscal years (e.g., fiscal year 2006).
BO = Biennially in odd fiscal years (e.g., fiscal year 2005).
CoC = Contaminant of concern.
DWS = Drinking water standard.
ND = Not detected.
xx = Not analyzed.

Appendix B

Well Construction Summary

Appendix B

Well Construction Summary

Table B.1 summarizes well construction information, including casing material, type of open interval (screened or perforated), elevation of open interval, and aquifer thickness. Table B.2 lists aquifer tube depths. All aquifer tubes are constructed of polyethylene tubing with a screened port in the aquifer.

Table B.1. Construction Information for Wells in the 100-BC-5 Monitoring Network

Well ID	Well	Year Drilled	Casing[a]	Screen[b]	Unit[c]	Open Interval Elevation, m		Water-Level Elev., m	Water-Level Date	Water Column, m[d]
						Top	Bottom			
A4550	199-B2-12	1992	SS	S	CR	84.53	81.49	120.64	1/31/2004	39.16
A4551	199-B2-13	1992	SS	S	TU	123.43	117.03	120.89	3/3/2004	3.86
A4552	199-B3-1	1953	CS	P	TU	127.79	115.59	120.17	3/3/2004	4.58
A4553	199-B3-46	1992	SS	S	TU	121.32	114.62	120.14	3/3/2004	5.52
A4554	199-B3-47	1992	SS	S	TU	122.27	115.87	120.03	3/3/2004	4.16
A4555	199-B4-1	1949	CS	P	TU	125.36	113.17	121.56	3/3/2004	8.39
A4557	199-B4-4	1960	CS	P	TU	129.97	113.82	121.71	3/3/2004	7.90
A5540	199-B4-5	1990	SS	S	TU	124.63	118.34	121.42	1/3/2002	3.08
A4558	199-B4-6	1990	SS	S	TU	124.59	118.30	121.77	2/2/2004	3.47
A5541	199-B4-7	1990	SS	S	TU	123.91	117.51	121.73	3/3/2004	4.22
A4559	199-B4-8	1992	SS	S	TU	125.63	119.20	121.73	1/31/2004	2.54
A4561	199-B5-1	1962	CS	P	TU	126.70	115.92	121.54	3/3/2004	5.62
A4562	199-B5-2	1992	SS	S	TU	124.42	118.32	121.91	2/2/2004	3.59
A4563	199-B8-6	1992	SS	S	TU	123.99	117.90	121.74	3/3/2004	3.84
A4565	199-B9-2	1992	SS	S	TU	125.06	118.96	121.78	1/31/2004	2.82
A4566	199-B9-3	1992	SS	S	TU	123.20	118.32	121.72	3/3/2004	3.40
A5293	699-63-90	1948	CS	P	UU	126.90	111.05	122.32	3/10/2004	11.27
A5302	699-65-72	unknown	CS	P	TU	123.85	117.76	121.88	3/10/2004	4.11
A5303	699-65-83	1967	CS	P	UU	129.76	111.47	121.73	3/10/2004	10.26
A5305	699-66-103	1944	CS	P	UU	139.29	103.32	121.53	3/9/2004	18.21
A5313	699-67-86	1962	CS	P	TU	125.73	112.57	121.72	3/9/2004	9.15
A5315	699-68-105	1952	CS	P	TU	124.73	111.63	121.46	3/9/2004	9.83
A5322	699-71-77	1962	CS	P	U	125.67	105.13	121.15	3/9/2004	16.02
A5323	699-72-73	1961	CS	P	U	128.84	105.37	121.21	3/9/2004	15.84
A5325	699-72-92	1961	CS	P	UU	123.64	109.06	121.32	3/9/2004	12.26

(a) Casing material. CS = carbon steel; SS = stainless steel.
(b) Open interval type. S = screen; P = perforated casing.
(c) Hydrogeologic unit monitored (based on data presented above and associated well logs).
TU = Top of unconfined aquifer (screened across water table with open interval ≤10 m below water table.
U = Undifferentiated unconfined. Open to more than 15 m of the unconfined aquifer system, or poorly documented.
UU = Upper unconfined. Screened across water table, open interval 10-15 m below water table, or screened below water table and <15 m below water table.
RC = Ringold confined aquifer.
(d) Thickness of water column in well (water-level minus bottom of open interval).

Table B.2. Construction Information for Aquifer Tubes in the 100-BC-5 Monitoring Network

Well ID	Hanford River Mile	Aquifer Tube Name	Year Drilled	Port Depth (ft bgs)	Port Depth (m bgs)
B8114	2.60	01-M	1997	16	4.88
B8115	2.60	01-S	1997	7	2.13
B8119	3.45	03-D	1997	13	3.96
B8120	3.45	03-M	1997	7	2.13
C4375	3.57	AT-B-1-M	2004	13.3	4.05
C4377	3.66	AT-B-2-D	2004	19	5.79
C4379	3.66	AT-B-2-M	2004	14	4.27
C4378	3.66	AT-B-2-S	2004	8.7	2.65
B81222	3.73	04-D	1997	25	7.62
B8123	3.73	04-M	1997	13	3.96
B8124	3.73	04-S	1997	8.3	2.53
B8125	3.89	05-D	1997	25.5	7.77
B8126	3.89	05-M	1997	17	5.18
B8127	3.89	05-S	1997	8.5	2.59
C4380	4.02	AT-B-3-D	2004	23.2	7.07
C4381	4.02	AT-B-3-M	2004	14.2	4.33
C4382	4.02	AT-B-3-S	2004	8.1	2.47
B8128	4.12	06-D	1997	23	7.01
B8129	4.12	06-M	1997	15.5	4.72
B8130	4.12	06-S	1997	8.8	2.68
B8131	4.27	07-D	1997	20	6.10
C4368	4.44	AT-B-4-S	2004	7.5	2.29
C4369	4.62	AT-B-7-D	2004	18.1	5.52
C4370	4.62	AT-B-7-M	2004	13.3	4.05
C4371	4.62	AT-B-7-S	2004	6.8	2.07
C4372	4.77	AT-B-5-D	2004	24	7.32
C4373	4.77	AT-B-5-M	2004	16.2	4.94
C4374	4.77	AT-B-5-S	2004	9.6	2.93
B8143	5.07	11-D	1997	10.5	3.20
B8146	5.33	12-D	1997	10	3.05

Aquifer tubes are completed at three relative depths in the unconfined aquifer: near the water table (S), mid-depth (M), and above the first less-permeable unit (D).

bgs = Below ground surface.

E-STARS[TM] Report
Task Detail Report
10/01/2004 0601

TASK INFORMATION			
Task#	DOE-AMCP-C-2004-0485		
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1		
Parent Task#		**Status**	Open
Reference		**Due**	
Originator	Corbin, Peggy A	**Priority**	None
Originator Phone	(509) 376-7371	**Category**	None
Origination Date	09/28/2004 1110	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	bcc: AMCP OFF File AMCP Rdg File B. L. Charboneau, AMCP E. B. Dagan, OES K. M. Hintzen, AMCP J. G. Morse, AMCP A. C. Tortoso, AMCP RECORD NOTE: A. Tortoso, AMCP, and E. Dagan, OES, have reviewed and concurred on the SAP. A draft verison of the SAP was provided to Dennis Faulk with EPA by e-mail on August 25, 1004.		

ROUTING LISTS

1	Route List	Inactive
	• Tortoso, Arlene C - Approve - Approved - 09/28/2004 1150	
	• Morse, John G - Approve - Approved - 09/28/2004 1137	
	• Charboneau, Briant L - Approve - Approved - 09/29/2004 1700	
	• McCormick, Matthew S - Approve - Approved - 10/01/2004 1725	
	• Hebdon, Joel B - Approve - Approved with comments - 10/01/2004 0747 ↳ *Routing List:* Route List - Inactive • Dagan, Ellen B - Approve - Approved - 09/29/2004 1012	
	• Hollowell, Betty L - Approve - Approved with comments - 09/29/2004 1048	
2	Sign List	Active
	• Weis, Michael J - Approve - Awaiting Response [signature] 10/13/04	
	• Klein, Keith A - Approve - Awaiting Response for [signature] 10/13/04	

ATTACHMENTS

Attachments	1. 04-AMCP-0485act.doc 2. Attach 04-AMCP-0485act.pdf

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COMMENTS

Poster	Hollowell, Betty L (Dawson, Jodi L) - 09/29/2004 1009

	Approve
	Approved with incorporation of comments. B. Williamson reviewed and concurred. The wrong disclaimer is on the document. On environmental documents we use a trademark disclaimer, not a legal disclaimer. Please have the correct disclaimer attached and legal disclaimer removed.
Poster	Hebdon, Joel B (Mays, Linda G) - 10/01/2004 0710
	Approve
	Approved by Cliff Clark (acting for Joel Hebdon) with the following comment: in the 1st sentence of letter, substitute the words "all field" with "sampling and analysis." (L. Mays, 10/1)

TASK DUE DATE HISTORY

No Due Date History

SUB TASK HISTORY

Subtask#	DOE-AMCP-C-2004-0485.1	
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1	
Originator	Hollowell, Betty L	
	Routing List	*No Active Routing List*

-- end of report --

OK

E-STARS™ Report
Task Detail Report
10/01/2004 0721

TASK INFORMATION			
Task#	DOE-AMCP-C-2004-0485		
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1		
Parent Task#		**Status**	Open
Reference		**Due**	
Originator	Corbin, Peggy A	**Priority**	None
Originator Phone	(509) 376-7371	**Category**	None
Origination Date	09/28/2004 1110	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	bcc: AMCP OFF File AMCP Rdg File B. L. Charboneau, AMCP E. B. Dagan, OES K. M. Hintzen, AMCP J. G. Morse, AMCP A. C. Tortoso, AMCP RECORD NOTE: A. Tortoso, AMCP, and E. Dagan, OES, have reviewed and concurred on the SAP. A draft verison of the SAP was provided to Dennis Faulk with EPA by e-mail on August 25, 1004.		

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	• Morse, John G - Approve - Approved - 09/28/2004 1137	
	• Charboneau, Briant L - Approve - Approved - 09/29/2004 1700	
	• McCormick, Matthew S - Approve - Awaiting Response MM 10/1/04	
	• Hebdon, Joel B - Approve - Awaiting Response ↳ *Routing List:* Route List - Inactive • Dagan, Ellen B - Approve - Approved - 09/29/2004 1012	
	• Hollowell, Betty L - Approve - Approved with comments - 09/29/2004 1048	
2	Sign List	Draft
	• Weis, Michael J - Approve - Awaiting Response	
	• Klein, Keith A - Approve - Awaiting Response	

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COMMENTS

Poster	Hollowell, Betty L (Dawson, Jodi L) - 09/29/2004 1009

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TASK DUE DATE HISTORY		
No Due Date History		
SUB TASK HISTORY		
Subtask#	DOE-AMCP-C-2004-0485.1	
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1	
Originator	Hollowell, Betty L	
	Routing List	*No Active Routing List*

-- end of report --

E-STARS™ Report
Task Detail Report
09/29/2004 1134

TASK INFORMATION

Task#	DOE-AMCP-C-2004-0485		
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1		
Parent Task#		**Status**	Open
Reference		**Due**	
Originator	Corbin, Peggy A	**Priority**	None
Originator Phone	(509) 376-7371	**Category**	None
Origination Date	09/28/2004 1110	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal

Instructions

bcc:
AMCP OFF File
AMCP Rdg File
B. L. Charboneau, AMCP
E. B. Dagan, OES
K. M. Hintzen, AMCP
J. G. Morse, AMCP
A. C. Tortoso, AMCP
RECORD NOTE: A. Tortoso, AMCP, and E. Dagan, OES, have reviewed and concurred on the SAP. A draft verison of the SAP was provided to Dennis Faulk with EPA by e-mail on August 25, 1004.

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- Morse, John G - Approve - Approved - 09/28/2004 1137
- Charboneau, Briant L - Approve - Awaiting Response
- McCormick, Matthew S - Approve - Awaiting Response

[redacted] for JBH 9/30/2004

↳ *Routing List:* Route List - Inactive
  - Dagan, Ellen B - Approve - Approved - 09/29/2004 1012 W/comment

- Hollowell, Betty L - Approve - Approved with comments - 09/29/2004 1048

2 Sign List — Draft

- Weis, Michael J - Approve - Awaiting Response
- Klein, Keith A - Approve - Awaiting Response

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COMMENTS

Poster Hollowell, Betty L (Dawson, Jodi L) - 09/29/2004 1009

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TASK DUE DATE HISTORY

No Due Date History

SUB TASK HISTORY

Subtask#	DOE-AMCP-C-2004-0485.1
Subject	Concur - Transmittal of the 100-BC-5 Operable Unit Sampling and Analysis Plan, DdOE/RL-2003-38, Rev. 1
Originator	Hollowell, Betty L
	Routing List *No Active Routing List*

-- end of report --